

# STONEFLIES (INSECTA, PLECOPTERA) FROM MUSEUM COLLECTIONS IN CROATIA

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Seventeen species of stoneflies (Plecoptera) were recorded from the stonefly collection of the Croatian Natural History Museum. Nine taxa (eight species) of stoneflies were recorded from the stonefly collection of Franjo Koščec from the Entomological Department of the Varaždin Municipal Museum. Eight species from Zagreb and two species from Varaždin were recorded for the first time for Croatia. Although small, these collections are important for the relatively poor stonefly fauna of Croatia with only 30 species recorded so far.

**Key words:** Plecoptera, collection, Croatia, Zagreb, Varaždin, Croatian Natural History Museum, Entomological Department of the Varaždin Municipal Museum, Franjo Koščec

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U maloj zbirci obalčara (Plecoptera) iz Hrvatskog prirodoslovnog muzeja utvrdili smo 17 različitih vrsta, a u maloj zbirci obalčara iz entomološke zbirke Franje Koščeca, smještene u Entomološkom odjelu Gradskog muzeja Varaždin, utvrdili smo 9 različitih svojti (8 vrsta). Osam vrsta iz Zagreba i dvije vrste iz Varaždina prvi su puta zabilježene za područje Hrvatske. Iako dosta male, ove su muzejske zbirke vrlo važne za relativno skromno istraženu faunu obalčara Hrvatske s trenutno poznatih 30 vrsta.

**Ključne riječi:** Plecoptera, obalčari, zbirka, Hrvatska, Zagreb, Varaždin, Hrvatski prirodoslovni muzej, Entomološki odjel Gradskog muzeja Varaždin, Franjo Koščec

## INTRODUCTION

The stonefly fauna of Croatia is poorly known with only 30 species so far officially recorded (SIVEC, 1980, 1985; POPIJAČ & SIVEC, 2008), based on reliable determination of adult stages. This number should be much higher because for some neighbouring countries about one hundred stonefly species are known (SIVEC, 2001).

Recently we had an opportunity to check again and revise a small collection of stoneflies from the Croatian Natural History Museum in Zagreb (SIVEC, 1985), and to compare it with the recently studied small stonefly collection of Franjo Koščec from the Entomological Department of the Varaždin Municipal Museum in Varaždin (POPIJAČ & SIVEC, 2008). We hereby present data on the distribution, ecology and the category of threat according to the IUCN criteria for all threatened species from these stonefly collections.

As almost no historical data are available on stoneflies from the territory of Croatia (SIVEC, 1985; POPIJAČ & SIVEC, 2008), these small collections are very interesting as contributions to the knowledge of the stonefly fauna in Croatia. In addition, they are historically very important because this old material was collected from the end of 19<sup>th</sup> century and mostly during the first half of 20<sup>th</sup> century, when streams and rivers were much less affected than today.

## MATERIAL AND METHODS

All specimens are dry and pinned and impossible to determine without special treatment. Specimens were placed in a wet chamber for a few hours to soften, genital segments were cut out and then cleaned in hot 10% KOH. Genitalia were stored in glycerol in micro-vials or mounted in Canada balsam on a transparent cellulose foil. As a rule, the genitalia preparations are attached to the specimen pin. All specimens from Varaždin were digitally photographed before the above-described procedure. Photos on DVD were deposited together with the collection at the Entomological Department of the Varaždin Municipal Museum (POPIJAČ & SIVEC, 2008).

Stonefly species or genera were identified using available literature of the nearest regions of Europe (ILLIES, 1955; AUBERT, 1959, 1963; KAČANSKI & ZWICK, 1970; SOWA, 1970; TABACARU, 1971; KIS, 1974; BERTHÉLEMY & LAUR, 1975; HYNES, 1977; LILLEHAMMER, 1988; RAVIZZA & VINÇON, 1998; RAVIZZA, 2002; SIVEC & STARK, 2002; GRAF & SCHMIDT-KLOIBER, 2003). Nomenclature and systematics are according to ZWICK (1973) and DEWALT *et al.* (2009).

In the section of Results and Discussion, the records from the Croatian Natural History Museum in Zagreb are marked with (Zg). The records from the Entomological Department of the Varaždin Municipal Museum in Varaždin are marked with (Vž).

## RESULTS AND DISCUSSION

order **Plecoptera**  
suborder **Arctoperlaria**  
superfamily group **Systemlognatha**  
superfamily **Perloidea** Latreille, 1802  
family **Chloroperlidae** Okamoto, 1912

Chloroperlidae Gen. sp.

(Vž) Varaždin, 27.05.1929, 1 ♀; Varaždin, 05.06.1950, 1 ♀ (svjetlo), leg. F. Koščec.

Reliable identification of the species from this family is possible only by the analysis of the male genitalia, which were not available.

family **Perlidae** Latreille, 1802genus *Dinocras* Klapálek, 1907*Dinocras megacephala* (Klapálek, 1907)

(Zg) Bregana, 06.07.1907, 1 ♀.

It is the only *Dinocras* species in Croatia, abundant and widely distributed over the large part of northern and central Croatia, and in the Dalmatian background. In Bavaria in the south of Germany it is considered a critically endangered (CR) species (WEINZIERL, 2003), because this is the northern border of its distribution area. On the other hand, in Austria, Slovenia and Croatia, it is not considered an endangered species, but as a least concern (LC) species (GRAF & KONAR, 1999; SIVEC, 2002; POPIJAČ, 2008).

genus *Marthamea* Klapálek, 1907*Marthamea vitripennis* (Burmeister, 1839)

(Zg) Agram, 23.05.1909, leg. R. V. Weingärtner, 1 ♀. First record for Croatia (SIVEC, 1985).

It is considered as regionally extinct species (RE) in Slovenia (SIVEC, 2002) and in Croatia (POPIJAČ, 2008), and as largely extinct in most of Europe (ZWICK, 2004), due to the pollution of the river potamon which this species used to inhabit. The nearest recent record of this very rare species is in the Rába River in Hungary (KOVÁCS & AMBRUS, 2000).

genus *Perla* Geoffroy, 1762*Perla burmeisteriana* Claassen, 1936 (syn. *Perla abdominalis* Burmeister, 1839)

(Zg) Crna Mlaka, 20.04.1908, 1 ♂; Plitvice, 04.06.1926, 1 ♂. First record for Croatia (SIVEC, 1985).

No adults were found recently, only a few larvae were found at the northern foot of the Papuk Mountain in the Slavonia region. Therefore, this species is considered as endangered (EN) in Croatia (POPIJAČ, 2008).

*Perla bipunctata* Pictet, 1833

(Zg) Zagreb, 15.06.1901, 1 ♂. First record for Croatia (SIVEC, 1985).

The taxonomic status of this species is currently very uncertain (SIVEC & STARK, 2002). Therefore, it is for the time considered as a data deficient (DD) species in Croatia (POPIJAČ, 2008).

*Perla grandis* Rambur, 1842 (Figs. 1 & 2)(Vž) without locality, 10.07.1908, 2 ♀ (1 with eggs), leg. F. Koščec; Varaždin, 10.07.1928, 1 ♂, leg. F. Koščec; Kamenica, 25.07.1929, 1 ♀ (*Perla maxima*), leg. F. Koščec; Kamenica, 14.07.1932, 1 ♀ (with eggs) (GMV 42.264), leg. F. Koščec; without locality, 15.06.1950, 1 exuvium, leg. F. Koščec. First record for Croatia (POPIJAČ & SIVEC, 2008).

The head pattern looks the same as that of the museum specimens in Prague and London, collected at the beginning of 20<sup>th</sup> century from Sava River near Zagreb (Croatia) and Zidani Most (Slovenia). Recently, this species could be found mostly in the Alps but these specimens do not have this type of head pattern. According to the older stonefly literature (ILLIES, 1955; KIS, 1974), this head



**Fig. 1.** *Perla grandis* Rambur, 1842, Varaždin, 10.07.1928, ♂, leg. F. Košćec.  
First record for Croatia (POPIJAČ & SIVEC, 2008).



**Fig. 2.** *Perla grandis* Rambur, 1842, Varaždin, 10.07.1928, ♂, leg. F. Košćec. Head detail.

pattern is typical for the species *Perla bipunctata*, but the eggs from females in Košćec collection are more similar to those of *Perla grandis* (SIVEC & STARK, 2002).

*Perla illiesi* Braasch & Joost, 1973

(Zg) Fužine, 07.06.1897, 3 ♂; Sljeme, 05.1955, 1 ♂.

It was described from Bulgaria, but in Croatia it is lately confirmed only from the northern border with Slovenia on the Istria Peninsula and in the Gorski kotar region (SIVEC & POPIJAČ, unpublished data). VU according to POPIJAČ (2008) and SIVEC (2002).

*Perla marginata* (Panzer, 1799)

(Zg) Samoborska gora, 06.1940, 1 ♂.

*Perla pallida* Guérin-Méneville, 1838

(Zg) Sljeme, 15.06.1918, 1 ♂. First record for Croatia (SIVEC, 1985).

*P. marginata* and *P. pallida* are two sibling species easily confused during identification of larval and adult stages. Both VU according to POPIJAČ (2008) and SIVEC (2002).

family **Perlodidae** Klapálek, 1909

subfamily **Isoperlinae** Frison, 1942

genus *Isoperla* Banks, 1906

*Isoperla illyrica* Tabacaru, 1971

(Zg) Vozilići, Istra, 25.05.1977, 1 ♂, leg. Perović.

It is an endemic species of the north-western Dinaric Balkan, described from the entrance of the Postojna Cave in southern Slovenia. Recently, we confirmed it from many karstic springs and streams in the Dalmatian background and in the northern Primorje region (including Krk Island). NT according to POPIJAČ (2008).

*Isoperla obscura* (Zetterstedt, 1840) (Fig. 3)

(Vž) Varaždin, 04.07.1928, 2 ♀, leg. F. Koščec; Varaždin, 05.06.1950, 2 ♂, leg. F. Koščec. First record for Croatia (POPIJAČ & SIVEC, 2008).

Once a widely distributed species in streams and large rivers of the northern Palaearctic region, but rarely found on the Balkan Peninsula (ILLIES 1955; KIS 1974). Recently, it is considered as regionally extinct (RE) or as critically endangered (CR) in many European countries (BINOT *et al.*, 1998; BRINKMANN *et al.*, 1999; GRAF & KONAR, 1999; KÜTTNER, 1999; WEINZIERL, 2003; BÖHME *et al.*, 2004). It was never confirmed in neighbouring Slovenia, and a decade ago it was restricted only to the Drau (Drava) River in the southern Austrian region Carinthia (GRAF & KONAR, 1999). Franjo Koščec collected this species most probably from a much cleaner and more natural Drava River close to the town of Varaždin, 80 and 60 years ago.

*Isoperla tripartita* Illies, 1954

(Vž) Varaždin, 13.07.1928, 2 ♂, leg. F. Koščec; without locality, 14.05.1929, 1 ♀, leg. F. Koščec; Varaždin, 09.06.1929, 3 ♂, 3 ♀, leg. F. Koščec; Kamenica, 20.07.1929, 1 ♀, leg. F. Koščec.

(Zg) Trnovec, Lika, 05.1948, 1 ♂, 1 ♀, leg. Igalffy; Trnovec, 05.1954, 1 ♂, 1 ♀.

This mostly spring and stream species is widely distributed in Central Europe and on the Balkan Peninsula (KIS, 1974; SIVEC, 1980). We found it recently in almost all parts of Croatia and at Franjo Koščec's localities in the Varaždin surrounding area. DD according to POPIJAČ (2008).

subfamily **Perlodinae** Klapálek, 1909

genus *Isogenus* Newman, 1833

*Isogenus nubecula* Newman, 1833 (Fig. 4)



**Fig. 3.** *Isoperla obscura* (Zetterstedt, 1840), Varaždin, 05.06.1950, ♂, leg. F. Košćec.  
First record for Croatia (POPIJAČ & SIVEC, 2008).



**Fig. 4.** *Isogenus nubecula* Newman, 1833, Varaždin, 17.04.1930, ♂, leg. F. Košćec.  
Regionally extinct species (RE) (POPIJAČ, 2008).

- (Zg) Karlovac, 04.05.1892, 1 ♀; without locality, 1 ♂. First record for Croatia (SIVEC, 1985).
- (Vž) Varaždin, 27.05.1929, 1 ♀, leg. F. Košćec; Varaždin, 17.04.1930, 1 ♂, leg. F. Košćec; Varaždin, 30.05.1930, 1 ♀ (GMV 42.263), leg. F. Košćec; Varaždin, 04.05.1947, 1 ♀, leg. F. Košćec.

This species is known only from older data and is very seriously endangered or already extinct (RE) in Croatia, as in many European countries (ZWICK, 1984; BINOT *et al.*, 1998; BRINKMANN *et al.*, 1999; GRAF & KONAR, 1999; KÜTTNER, 1999; SIVEC, 2002; WEINZIERL, 2003; BÖHME *et al.*, 2004; POPIJAČ, 2008). A vital population is recently known from the Rába River in Hungary and the Lafnitz River in Austria (KOVÁCS *et al.*, 2004).

genus *Perlodes* Banks, 1903

*Perlodes intricatus* (Pictet, 1841)

(Zg) Karlovac, 20.05.1892, 1 ♀. First record for Croatia (SIVEC, 1985).

According to ILLIES (1955), it is a typical alpine species of small and clean mountain streams (800–2000 m a.s.l.). Recently, we found it during summer at the big karstic spring area of Kupa River, together with *Perlodes microcephalus*. A probable new *Perlodes* species, similar to *P. inticatus*, is common at karstic spring areas in the Plitvice Lakes National Park with adults emerging during summer. Still, there is little data available on any *Perlodes* species in Croatia. Therefore, they are for the time considered as data deficient (DD) species in Croatia (POPIJAČ, 2008).

superfamily group **Euholognatha**

superfamily **Nemouroidea** Newman, 1853

family **Leuctridae** Klapálek, 1905

genus *Leuctra* Stephens, 1836

*Leuctra hippopus* Kempny, 1899

(Zg) Hruškovec, 24.05.1918, 1 ♀.

It is the only species of the genus *Leuctra* in the studied museum collections, most probably because this genus and family are the largest in number of species but among the smallest in body size. LC according to POPIJAČ (2008).

family **Nemouridae** Newman, 1853

subfamily **Amphinemurinae** Baumann, 1975

genus *Amphinemura* Ris, 1902

*Amphinemura standfussi* (Ris, 1902)

(Vž) Kamenica, 07.07.1934, 1 ♀, leg. F. Koščec; Kamenica, 15.07.1934, 1 ♂, leg. F. Koščec; Kamenica, 18.07.1934, 1 ♂, leg. F. Koščec; Kamenica, 10.08.1934, 1 ♀, leg. F. Koščec.

SIVEC (unpublished data) recorded this species in Croatia only once before (Prijeboj, 19.09.1987, 1 ♂, 6 ♀, leg. I. Sivec). Recently, we collected many adults of this species during June 2008, from the same locality where Franjo Koščec collected it 74 years ago. LC according to POPIJAČ (2008).

genus *Protonemura* Kempny, 1898

*Protonemura auberti* Illies, 1954

(Zg) Sljeme, 25.05.1931, 1 ♀. First record for Croatia (SIVEC, 1985).

Recently, this species was found to be a very abundant spring and summer species at the karstic spring areas in the Plitvice Lakes National Park, the largest and the oldest National Park in Croatia (from 1949, and on UNESCO list from 1979). LC according to POPIJAČ (2008).

*Protonemura intricata* (Ris, 1902)

(Vž) Kamenica, 15.08.1934, 1 ♀, leg. F. Koščec.

This is one of the common summer species. In contrast, the other *Protonemura* species mostly emerge during spring or autumn. LC according to POPIJAČ (2008).

subfamily **Nemourinae** Newman, 1853

genus *Nemoura* Latreille, 1796

*Nemoura cinerea* (Retzius, 1783)

(Vž) Varaždin, 13.07.1928, 2 ♀, leg. F. Koščec; Kamenica, 08.07.1934, 1 ♂, leg. F. Koščec.

(Zg) Trnovec, Lika, 09.1942, 1 ♀, leg. Igalffy; 05.1954, 1 ♀; 06.1955, 1 ♀; Crna Mlaka, 29.04.1908, 1 ♀; Čerević, 30.05.1910, 1 ♀; Otočac, 18.07.1912, 1 ♀; Zagreb, 02.05.1895, 1 ♀; Prezid, 19.07.1903, 1 ♀; Lika, 06.1950, 1 ♀; Peščenica, 13.05.1974, 1 ♀, leg. Perović; Gata, Split, 11.05.1960, 1 ♂, leg. Novak.

*Nemoura cinerea* is one of most frequently collected and abundant stonefly species, because it is very tolerant to organic pollution. In addition, it is one of few stonefly species living also in ponds and lakes, in addition to streams and rivers. Recently, we also confirmed this species during June 2008 from Franjo Koščec's locality, Kamenica. LC according to POPIJAČ (2008).

genus *Nemurella* Kempny, 1898

*Nemurella pictetii* (Klapálek, 1900)

(Zg) Hruškovec, 24.05.1918, 1 ♂.

(Vž) Kamenica, 08.07.1934, 1 ♀, leg. F. Koščec.

This is another frequently collected and abundant stonefly species, and the only European species known to have more than one generation per year (WOLF & ZWICK, 1989). LC according to POPIJAČ (2008).

family **Taeniopterygidae** Klapálek, 1905

genus *Brachyptera* Newport, 1848

*Brachyptera risi* (Morton, 1896)

(Zg) Rieka, 14.04.1901, 1 ♂; Lokve, 28.05.1901, 1 ♀.

*Brachyptera seticornis* (Klapálek, 1902)

(Zg) Sljeme, 25.05.1931, 1 ♂, 5 ♀. First record for Croatia (SIVEC, 1985).

These two *Brachyptera* species are common and abundant in the mountain streams of northern Croatia, and they are often found together at the same localities, as, for example, in some streams on the Medvednica Mountain above the Croatian capital Zagreb. Both LC according to POPIJAČ (2008).



## CONCLUSIONS

Seventeen species of stoneflies (Plecoptera) were recorded from the small collection of the Croatian Natural History Museum. Nine taxa (eight species) of stoneflies were recorded from the small stonefly collection of Franjo Koščec situated at the Entomological Department of the Varaždin Municipal Museum.

The species composition of these collections indicates their completely accidental nature. The genus *Leuctra*, largest in number of species but smallest in size, is represented by one species, with one specimen in one collection only (Zg). It suggests that all the material was collected merely incidentally during other entomological activities from May to August. Common and abundant species are mostly found in stonefly collections made by entomologists with no expertise in stoneflies.

In contrast to the lack of small and early spring species, in addition to late autumn and winter species, nearly all the expected representatives of the larger sized, late spring and summer Perlidae are present.

These data are extremely interesting and important from the zoogeographical and historical point of view. Rapidly increasing destruction of habitats and water pollution has made some of these species rare or already extinct, not only in our waters but also widely in Europe. MALICKY (2009) found similar rare potamal Trichoptera in this collection from Varaždin from about the same time.

The historical importance of this stonefly collection lies in its confirmation of the fact that natural streams and rivers were much less affected and richer in stonefly species in the past. These rare, but historically significant findings are encouraging us to put more effort in trying to relocate These rare and sensitive stonefly species at the same localities where they were collected from the end of 19<sup>th</sup> century and during the first half of 20<sup>th</sup> century.

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## SAŽETAK

### Obalčari (Insecta, Plecoptera) u muzejskim zbirkama u Hrvatskoj

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U maloj zbirci obalčara (Plecoptera) iz Hrvatskog prirodoslovnog muzeja utvrdili smo 17 različitih vrsta, a u maloj zbirci obalčara iz entomološke zbirke Franje Košćeca, smještene u Entomološkom odjelu Gradskog muzeja Varaždin, utvrdili smo 9 različitih svojti (8 vrsta).

Osam vrsta iz Zagreba i dvije vrste iz Varaždina prvi su puta zabilježene za područje Hrvatske. Iako dosta male, ove su muzejske zbirke vrlo važne za relativno skromno istraženu faunu obalčara Hrvatske s trenutno poznatih 30 vrsta, budući da čak trećinu tog broja predstavljaju novootkrivene vrste iz ovih zbirki.

U analiziranim zbirkama nema ranih ni kasnih vrsta obalčara, jer je sav materijal sakupljan u periodu od svibnja do kolovoza. Iako se u zbirkama obalčara koje su sakupljali nespécialisti za tu skupinu kukaca uglavnom nađu neke najčešće i najbrojnije vrste, u analiziranim zbirkama nađene su ipak i neke jako zanimljive, osjetljive te izumrle vrste obalčara. Time je još više naglašen povijesni značaj ove zbirke, jer nam potvrđuje i činjenicu da su prirodne tekućice nekada davno izgledale dosta drugačije i bile bogatije vrstama obalčara nego što su to danas. Ovakvi mali i rijetki, ali povijesno jako značajni nalazi, neprestano nas potiču da uporno i dalje pokušavamo pronaći te vrste obalčara na istim lokalitetima na kojima su sakupljane od kraja 19. stoljeća te uglavnom tijekom prve polovice 20. stoljeća.